Effects of Fuel Additives on General Aviation Aircraft Fuel System Component Electrochemical Corrosion

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Abstract

Replacement of leaded aviation fuels with viable non-leaded alternatives continues to be a concern of environmentalists, industry representatives, and federal regulatory agencies. The elimination of tetra ethyl lead (TEL), which is now used in 100 LL aviation gasoline (avgas) as a fuel additive, is a certainty when acceptable alternative fuel additives are approved in the future. This will be a significant event for the general aviation community. Besides being an octane enhancer, TEL has an advantage in preventing wear of some engine components.

Among the octane enhancing additives that are being considered as replacements of TEL are ethyl-tertiary-butyl ester (ETBE) and anhydrous ethanol. ETBE has its own environmental concerns because of the ground water contamination problems that have been encountered with the chemically similar automotive fuel additive methyl-tertiary-butyl ether (MTBE). Ethanol has also been suggested as an octane-enhancing additive for general aviation (GA) fuel. Ethanol is becoming increasingly popular within many public and legislative circles because it is completely biodegradable and it is a renewable resource.

With the possibility of increasing pressures to employ the use of ethanol as a fuel additive in some types of GA aircraft, it is prudent to investigate potential fuel system materials problems that may arise as a result of this fuel's use. Fuel system components common to many aircraft fuel systems are fabricated using aluminum alloys, steel, and brass.

Since the metal components that make up fuel tanks, plumbing systems, and metering systems are located at different points on the galvanic series, there exists a possibility for electrochemical corrosion to take place in the fuel systems due to activity between two dissimilar metals. Anecdotal evidence of such corrosion has been reported in fuel systems of light aircraft. Preliminary results from the current research project have measured electrode potentials of more than 0.5 volts for aluminum-brass electrodes and more than 0.4 volts for aluminum-steel electrodes when in the presence of an electrolyte made up of gasoline-ethanol blends compared to electrode potentials of less than 0.001 volts for pure gasoline.

The objective of this research project is to examine the potential for electrochemical corrosion for the various gasoline-ethanol blends that have been proposed. The ethanol compositions of interest vary from the standardized automotive10% ethanol gasohol blend up to the 85% ethanol aviation gasoline blend that has been proposed by others. An additional parameter to be studied is the effect of absorbed water on the conductivity

of the fuel. The justification being that the presence of ethanol will cause the fuel to absorb significant amounts of water without the characteristic phase separation associated with water contamination in fuel.

Some aircraft require 80 octane fuels while other aircraft require 95 or higher-octane fuel. Aircraft whose engines are approved for 80 octane fuels are eligible to receive a Supplementary Type Certificate (STC) to use auto gas as fuel. The STC covers roughly 60% of the GA fleet. The STC does not include the use of gasohol fuels, however, due to increased use of gasohol in some states and the elimination of pump labeling requirements, the potential for cross-contamination of alcohol blended auto fuel exists. In order to obtain information on the extent of auto fuel use, surveys are being made and samples collected from aircraft that use auto fuel. The results of that survey confirmed that cross contamination has occurred in the past.

The overall objectives of this project are to identify and document potential problems with ethanol fuel additives and to recommend possible remedies to those problems. Possible remedies could include modification of the annual inspection process, education of pilot-owners related to the use of auto fuel and long term storage of fuels that may be suspect, and the development of low-cost fuel conductivity measuring devices that may be used by pilots to detect unfavorable conductivity characteristics of their onboard fuel supply.